Appendix B
Facilitating Risk Analyses

Last Updated on March 3, 2000

Facilitators are assigned to risk analysis (RA) teams to assist them through the process. The facilitator contributes to the process by bringing experience with risk analyses, consistency in approach, knowledge of latest technology in risk analyses, and as a resource to the design team for questions.

Getting Started

The design team leader (TL) will schedule and coordinate the RA meeting. Issues that need to be considered by the TL in planning for the meeting are as follows:

- The level of RA to be conducted by the team. Part III.A. of the Dam Safety Risk Analysis Methodology (Methodology) should be reviewed with the facilitator to ensure the appropriate issues are adequately addressed by the RA and the decision makers receive the necessary information and guidance. It may also be that only specific areas of risk at a dam will need to be explored by the team. Conclusions from this step should be reviewed with the Dam Safety Office Program Manager and other decision makers.

- Determine the status of hydrologic, seismic, and Loss of Life studies. Each RA can require its own level of information from these studies that will be needed in advance of the meeting. See Attachment A for a breakdown of the information likely to be needed.

- Determine the RA team membership. The plans for staffing the RA team should be reviewed with the facilitator to assure the necessary expertise will be present to address the issues. The team member roles during the meeting should be determined. Key roles include recorder (who is generally also the lead author of the final report), briefing statements (determine who is to provide these to the team during the RA), the @Risk operator (if needed), and who will be the expert estimators on the specific topics. Determine where expertise outside the team is necessary.

- The TL and facilitator should determine if there are certain key documents that will need to be reviewed by the team in advance, such as existing analysis reports on the dam in question (e.g., SEED, MDA, or Issue Evaluation TMs; Reports of Findings, CFR Reports, etc.). Other reports that might be useful are some selected case histories pertinent to the issues to be evaluated, and possibly some articles on RA principles and bias.

- Determine the required products of the risk analysis and the schedule for completing these products.

Prior to the meeting

Immediately prior to the meeting, certain tasks need to be addressed. These include:

- A review of the key documents by the RA team, as designated as a minimum by the TL and

facilitator (see above).

- Familiarity by all team members with the Methodology and Reclamation's "Guidelines for Achieving Public Protection in Dam Safety Decision Making" will be necessary.

- Where there have been some preliminary decisions made (scope of RA, experts to be used, method of RA to be used), the Facilitator will assure that the documentation of these gets to the Recorder for inclusion in the final report.

During the meeting

The Facilitator will normally chair the RA meeting to ensure the meeting stays on track and the team focuses on the issues to be addressed.

A generic agenda for the RA meeting is given in Attachment B.

The Facilitator may have kick-off discussions on the objectives of the RA (clients needs); team makeup; constraints of time, manpower, lack of knowledge; bias; work already accomplished (including previous risk analyses).

The Facilitator will monitor the flow of the meeting and instigate adjustments during the meeting to help maintain focus.

The Facilitator may make use of the flip chart format and the Verbal Descriptors provided in Attachment D during the meeting to help the team in formulating their probability estimates.

The Facilitator works with the recorder throughout the meeting to ensure the proper information is being collected for future documentation.

Following the meeting

The RA Team, rather than the Facilitator, is tasked with preparing the report documenting the Risk Analysis. Attachment C can be consulted for a general outline of what to include in the report. Typically the recorder will prepare the initial draft of the report with the remainder of the team contributing as necessary. The Facilitator will serve as a reviewer of the report and will certify that the risk analysis followed the Methodology and adequately addressed the necessary issues. See section V.C. of the Methodology for a description of the documentation and review process.

The Facilitator can be consulted concerning questions or for applicable examples of other risk analyses if desired.

ATTACHMENT A

TYPICAL INFORMATION NEEDED FOR A RISK ANALYSIS

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l. Loss of Life Estimates

a. Contact GIS/remote sensing group to see if and when estimates of PAR using census data and inundation maps can be available, if this level of detail is required.

b. Locate inundation maps (Wayne Graham, SOP, or Area Office representative).

c. Ask Wayne Graham to dig up information from all past studies of Loss of Life potential.

d. See if area or regional office representative has other relevant information, particularly site specific and seasonal PAR information.

e. Determine if Early Warning System (EWS) has been installed and tested.

2. Hydrologic Loadings

a. Contact flood specialists from the Flood Cadre to obtain current flood frequency analysis.

b. Contact the appropriate staff from D-8130 concerning the flood routings to see if a relationship of maximum reservoir water surface versus probability can be provided.

3. Static Loadings

a. Contact the assigned instrumentation person in D-8460 to ensure that all current instrumentation data and interpretations will be available. Instrumentation Data books should be brought to the RA meeting.

4. Earthquake Loadings

a. Contact the seismotectonic specialist for the probabilistic seismic hazard assessment to be used in the RA.

b. MCE magnitude and distance.

c. Cyclic shear stress estimates for various load (acceleration) ranges for embankment dams, if available.

5. Hydrologic System Response

a. Expected spillway and outlet works operations performance during flood events.

b. Elevation (survey) data for top of dam. (Low spots, high spots)
c. Surface features and conditions. (Crest and downstream slope)

6. Static System Response

a. Condition of outlet works and surrounding materials.

b. The following information is helpful in assessing failure mechanisms associated with seepage and piping through foundations or embankment dams:

- Geological setting and history (including jointing, layering, cavities, soluble materials, etc.)
- Seepage quantity, location and path
- Potential exits (observable or not)
- Analysis of seepage
- Damsite topography and dam x-section
- Conduits/penetrations
- Instrumentation results including settlement, deformations, piezometers
- Operational history including current operations
- Turbidity and dissolved solids of observed seepage
- Construction records
- Permeability and material properties of dam and foundation
- Case histories
- Failure frequency from case histories (see Fell and Foster's 12/97 report)
- Geophysical surveys
- Foundation history

c. Results of completed stress and stability analyses for concrete dams and their foundations.

d. Landslide concerns, if any.

7. Earthquake System Response

a. Dam and foundation materials data.

b. Blow count data, shear wave velocities, or other similar data for potentially liquefiable foundation materials.

c. Results of deformation analyses, if any.

d. Results of completed stress and stability analyses for concrete dams and their foundations.

8. Other Data

a. Reservoir water surface elevations versus percent of time RWS is lower (or higher). This should be obtained from local operations personnel or Instrumentation.

b. Original specification, Performance Parameter TM, CFRs, SEED Reports, TMs, other dam modification specs, other reports.

c. SEED Data Books should be brought to the RA meeting.

4. Determine if site specific intervention actions are possible for specific failure modes that might mitigate the failure potential

ATTACHMENT B

RISK ANALYSIS MEETING AGENDA

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1) Introduction of team members and their responsibilities

2) Quick reviews of:
   a. Dam
   b. Geology
   c. Appurtenant structures
   d. Instrumentation data
   e. Operations of the reservoir and dam
   f. Flood loadings
   g. Seismicity
   h. What's downstream
   i. SOD deficiencies

3) Discuss and identify potential failure modes

4) Develop Loss of life estimates
   a. Population at risk
   b. Warning time estimates
   c. Loss of life

5) Seismic event tree
   a. Load ranges
   b. Probability estimates
   c. Review team's estimates

6) Hydrologic event tree
   a. Load ranges
   b. Probability estimates
   c. Review team's estimates

7) Static event tree
   a. Applicable factors for piping or instability
   b. Probability estimates
   c. Review team's estimates

8) Review risk analysis calculations and results

9) Discuss presentation of the results, the conclusions reached, and the recommended actions. As part of this discussion consider the following questions:

   1) What failure modes create the highest risk?
   2) What are the uncertainties for the highest risk?
   3) What data or analysis would reduce the uncertainly?
   4) What is the anticipated action of gathering more data/performing more analysis?
   5) How would these outcomes impact risk?
   6) Where do we go? What will it cost?

10) Set future schedules
   a. Draft report sections written
   b. Review

c. Next meeting to discuss final results
d. Final report
e. Briefing to DSO, Area, and Region

ATTACHMENT C

OUTLINE FOR RISK ANALYSIS REPORT

Table of Contents and List of Tables and Figures (if necessary)

1.0 Scope of Risk Analysis

2.0 Introduction
- 2.1 Participants
- 2.2 Brief description of dam and appurtenant structures
- 2.3 Summary of past dam safety studies and analyses

3.0 Hydrologic Loads and Failure Modes
- 3.1 Hydrologic loads and probabilities
- 3.2 Hydrologic Failure Modes and Breach Parameters

4.0 Seismic Loads and Failure Modes
- 4.1 Seismic loads and probabilities
- 4.2 Seismic Failure Modes and Breach Parameters

5.0 Static Loads and Failure Modes
- 5.1 Static loads and reservoir operations
- 5.2 Static Failure Modes and Breach Parameters

6.0 Consequences from Failure Modes
- 6.1 Population at Risk
- 6.2 Warning Assumptions
- 6.3 Loss of Life Estimates

7.0 Event Trees and Probability Estimates
- 7.1 Hydrologic
- 7.2 Seismic
- 7.3 Static

8.0 Uncertainty

9.0 Conclusions

10.0 Recommendations

11.0 References

Appendix A - Event Trees

Appendix B - Hydrologic data

Appendix C - Seismic data

Appendix D - Consequences data

ATTACHMENT D

Description of specific event within the failure mode of concern	
Factors or data <u>for</u> the event occurring	**Factors or data <u>against</u> the event occurring**
Summarize the reasonable high and reasonable low probability estimates reached by consensus and the likely probability distribution for this event	

Verbal Descriptors		
<u>Verbal Likelihood Assessment</u>	**<u>Example</u>**	**<u>Probability</u>**
Virtually certain		0.999
Very likely	You've got 1 black ball and 99 white balls in a jar you can't see through. Chance of picking the black ball.	0.99
Likely		0.9
Neutral	Chance of flipping a coin and getting heads	0.5

Unlikely		0.1
Very unlikely	You've got 4 bad spark plugs and 4 good spark plugs mixed up on a table top. Chance of picking all four good plugs on the first try	0.01
Virtually impossible		0.001